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CASE SERIES

DRY NEEDLING IN THE MANAGEMENT OF PATIENTS MEETING CLINICAL DIAGNOSTIC CRITERIA FOR SUBACROMIAL PAIN SYNDROME: A CASE SERIES

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ABSTRACT

Background: Physical therapy interventions of exercise and manual therapy provide benefit in treatment of subacromial pain syndrome (SAPS). Dry needling is an emerging technique for treating musculoskeletal conditions; however, conflicting investigative evidence exists regarding the use of dry needling for SAPS.

Purpose: The purpose of this case series was to describe the use of dry needling, in conjunction with exercise, as a management strategy for patients meeting clinical diagnostic criteria of SAPS and to observe the short- and intermediate-term effects of dry needling with therapeutic exercise in this population. A secondary purpose was to describe a framework of clinical reasoning to guide the pragmatic application of dry needling and exercise in clinical practice.

Study Design: Case series.

Methods: Twenty-five patients met criteria for SAPS and provided informed consent. Patients received examination-based dry needling for the first two visits with exercises added beginning at the third treatment session to help distinguish treatment effects. The primary outcome measure used in this study was the Quick Disabilities of the Arm, Shoulder, and Hand (Q-DASH) survey assessed at their third clinical visit, at four-weeks after starting intervention and again at a three-month follow up visit.

Results: On the Q-DASH survey 21 of 24 patients reported improvement at the third visit (range 4.5 to 38.6 points) and 19 of 22 reported improvement at the 3-month follow-up (range 0.1-54.5 points) relative to baseline. Sixteen of 24 patients at the third visit and 19 of 22 patients at the 3-month follow-up reported Global Rating of Changes scores of +3 or greater.

Conclusion: This case series provides insight to the observed short- and intermediate-term effects of dry needling combined with exercise for SAPS. Additionally, it discusses the framework of clinical reasoning when applying this intervention. The results are encouraging for dry needling as an adjunct to exercise for treating patients with SAPS.

Level of Evidence: Therapy, level 4

Key Words: Movement system, shoulder, trigger point, subacromial pain syndrome,

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INTRODUCTION

Shoulder pain accounts for 14-21 % of all primary care musculoskeletal complaints with an estimated direct cost of $7 billion per year in the United States.[1-4] Subacromial pain syndrome (SAPS) involves a spectrum of subacromial space pathologies, including partial thickness rotator cuff tears, rotator cuff tendinosis, calcific tendinitis, and subacromial bursitis.[5] Common interventions for SAPS include medication,[6,7] exercise,[8] manual physical therapy,[9-11] injections and surgery.[7,12-14] Surgery and injections may not provide any additional benefit over lower risk physical therapy strategies.[9,11-13] Exercise programs aim to improve shoulder motion, scapular and rotator cuff muscle strength, and shoulder function, in order to reduce pain in patients with SAPS.[8,10] The addition of manual physical therapy to a comprehensive exercise program results in greater reduction in pain and improvement in function as well as greater improvements in strength compared to exercise alone.[8-10] Recent guidelines also recommend considering the treatment of myofascial trigger points in the management of SAPS,[5] which have been identified as a common source of symptoms in patients with unilateral, non-traumatic shoulder pain.[15]

Dry needling is an emerging treatment technique in which a monofilament needle is inserted in areas of trigger points resulting in a local twitch response (contraction of the muscle). Several systematic reviews suggest measured benefits related to dry needling in multiple body areas in order to reduce pain and improve function.[24-26] A 2015 systematic review specifically of dry needling for neck and shoulder pain recommended dry needling for treating trigger point pain in the short- and intermediate-term effects.[27] More recent evidence on the effectiveness of dry needling for SAPS is mixed. A 2017 randomized clinical trial found large between group effect sizes in shoulder disability favoring the addition of dry needling to a therapeutic exercise program at 3-month, 6-month, and 12-month follow-up.[28] However another 2017 trial found no intermediate- or long-term differences in pain or function between groups that receive individualized physical therapy compared to individualized physical therapy with dry needling.[29]

Currently there is minimal information regarding the process of utilizing dry needling as well as a lack of discussion regarding the framework of clinical reasoning in the application of dry needling throughout an episode of care for patients with SAPS. Moreover, it is possible that differences in the dry needling treatment parameters could explain the different outcomes between the two previously mentioned 2017 clinical trials.[28,29] Studies are needed that specifically document the details of dry needling utilization including specific examination findings, treatment parameters, and individualized patient responses. Therefore, the purpose of this case series was to describe the use of dry needling, in conjunction with exercise, as a management strategy for patients meeting clinical diagnostic criteria of SAPS and to observe the short and intermediate term effects of dry needling with therapeutic exercise in this population. Additionally the authors discuss how a framework of clinical reasoning may be applied in the utilization of dry needling and exercise in an examination-based pragmatic approach to treating patients with SAPS.

METHODS

Patients

Twenty-five patients referred to physical therapy for shoulder pain met the inclusion and exclusion criteria (Table 1) and agreed to participate in this study after a formal informed consent process. Patients in this study received treatment between March and November of 2014. Patients were informed that the data collected during this study would be submitted for publication and that their information would be protected in accordance with the U.S. HIPPA provisions. This study was approved by the *IRB* of Brooke Army Medical Center, Fort Sam Houston, Texas.

Outcome Measures

The primary outcome measure used in this study was the Quick Disabilities of the Arm, Shoulder, and Hand (Q-DASH) survey which is reliable (Cronbach's α .92-.95) and valid (Pearson's correlation to Shoulder Pain and Disability Index .84), and is responsive to symptom and functional change across a number of shoulder pathologies.[32] The Q-DASH includes eleven items scored on a 1-5 scale resulting in a value that is transformed to a 100-point scale. Higher scores on the Q-DASH indicate greater disability. The reported normative value of the Q-DASH in

Table 1. *Inclusion and Exclusion Criteria.*

Inclusion Criteria	Exclusion Criteria
• 18-65 years of age • Eligible for military health care • 3 or more positive SAIS tests: Hawkins-Kennedy, Neer, painful arc, empty can, and pain with resisted external rotation[5, 43] • Pain located in the anterior and/or lateral shoulder region • Sufficient English language skills	• Pending litigation or worker's compensation • Exam suggestive of adhesive capsulitis • History of shoulder fracture • Cervical radiculitis or radiculopathy • History of systemic or neurological disease • PT or chiropractic treatment in last 6 months • Currently taking anticoagulation medication or history of bleeding disorder

Table 2. *Outcome Measure Data Collection Timeline.*

	Initial Exam	Visit 2	Visit 3	4-Weeks	3-Months
Q-DASH	X	X	X	X	X
NPRS	X	X	X	X	X
Abduction AROM	X	X	X	X	X
GROC		X	X	X	X

Outcome measures were obtained prior to further examination and treatment at each timepoint.
Q-DASH: Quick Disabilities of the Arm, Shoulder, and Hand
NPRS: Numeric Pain Rating Scale
AROM: Active Range of Motion
GROC: Global Rating of Change

the general population is 10.1 (SD 14.7)[33] and the minimal clinically important difference (MCID) is a change of 15.9 points on the 100-point scale.[34]

Secondary outcome measures included the Numeric Pain Rating Scale (NPRS), shoulder abduction active range of motion (AROM), and the Global Rating of Change (GROC) scale. The NPRS is an 11-point numeric scale on which patients rate their worst level of pain in the last 24 hours, best level of pain in the last 24 hours, and their current level of pain. In this study, an average of these three reported values was used to represent a patient's pain level as described by Michener.[35] The reported MCID for the NPRS ranges from a 1.1-2.17 point change on the 11-point scale.[35,36] A change value of two points on the NPRS was used for the MCID. With the identified contributing factors in this patient population of working overhead and throwing,[37,38] shoulder abduction AROM was selected as an objective measurement because it is a physiological movement frequently required to get into the functional overhead position. We measured abduction AROM in standing as described by Muir et al.[39] While supine AROM is reported to have greater reliability,[39] measuring in standing and rounding to the nearest 5 degrees is more consistent with examination in clinical practice due to it being more functionally relevant and clinically expedient. A Minimum Clinical Difference (MCD) of 11 degrees was used for standing shoulder abduction when performed by a single rater in this study.[39] The GROC is a 15-point Likert scale whereby patients rate their perceived change in their condition.[40] The scale ranges from -7 ("a very great deal worse") to zero ("about the same") to +7 ("a very great deal better"). In this study, GROC scores of +3 ("somewhat better") or greater were determined to represent clinically meaningful improvement.[40]

Patients completed the Q-DASH and NPRS and the treating therapist measured shoulder abduction AROM at baseline and at the second and third treatment sessions, then again at the four-week and three-month follow-up appointments. Patients provided their GROC at the second and third treatment sessions and at the four-week and three-month follow-up appointments. Outcome measures were assessed prior to additional intervention at each measurement interval. (Table 2)

Examination

After completing the baseline self-report questionnaires, patients participated in a comprehensive patient-focused interview and an appropriately

tailored physical examination at a vigor based on the severity and irritability of symptoms.[41,42] Clinical reasoning is required to prioritize diagnostic hypotheses, determine structures to be examined, choose the corresponding examination procedures and discern how interventions will be used to address findings from the examination. The initial physical examination included manual examination of physiologic active and passive shoulder range of motion (ROM), manual muscle testing (MMT) of the shoulder, impingement provocation tests,[43] and careful palpation of soft tissue structures including muscles and tendons in the shoulder region. Shoulder AROM, MMT, and impingement provocation tests were performed with the patient in standing, while passive shoulder ROM was evaluated with the patient lying supine on an examination table with the examining therapist observing and documenting changes in symptoms with each examined motion. Palpation of anterior musculature performed with the patient lying in supine included the pectoralis major and minor, anterior and middle deltoid, coracobrachialis, and biceps muscles. Palpation of posterior musculature performed with the patient lying in prone included the supraspinatus, infraspinatus, teres minor and major, posterior deltoid, latissimus dorsi, rhomboid minor and major, lower/middle/upper trapezius, cervical paravertebral, and thoracic paravertebral muscles.

Careful and thorough palpation was conducted by the examining therapist for the identification of trigger point taut bands and/or areas that reproduced the patients' familiar symptoms.[22,23] Some discomfort is not uncommon when palpating muscles so it was important for the therapist in these cases to differentiate between what was potentially "normal" discomfort and areas that produced the patients' familiar symptoms. These areas were documented by the therapist based on the level of pain and how closely it correlated with the patients' familiar symptoms. This allowed the physical therapist to prioritize muscles and trigger points for treatment during the first visit. Primary trigger points were identified in muscles where taut bands were more pronounced and/or muscles which most closely produced the patients' familiar symptoms upon palpation. Secondary trigger points were classified by the presence of taut bands and/or symptom production with a lesser degree of correlation to the patients' familiar symptoms. All patients participating in this study had at least one area upon palpation that met the criteria for a trigger point.

At each visit, the physical therapist re-evaluated the previous relevant findings and added to the examination by incorporating examination of the cervical spine, thoracic spine, rib cage and elbow. If these adjacent regions were judged to be contributing to the patient's shoulder complaint, intervention in the form of joint mobilization, soft tissue mobilization, nerve glides, or exercise were added to the plan of care program. The most commonly used manual examination of passive accessory motions of the shoulder included superior-to-inferior, anterior-to-posterior, and posterior-to anterior glides of the head of the humerus in the glenoid and nerve mobility.[44] At successive treatment sessions, the physical therapist also reassessed previously identified trigger points, examined for new trigger points, and re-prioritized treatment based on evaluation of the relative contribution to the patients ongoing symptoms and functional limitations.

Interventions

The treatment approach in this study consisted of dry needling into trigger points within the region of the shoulder followed by the integration of upper quarter strengthening and range of motion exercises[9,10,45] to address specific impairments identified upon examination. One physical therapist with seven years of clinical experience completed all the examinations and interventions on the patients. The physical therapist had three years of dry needling experience (2010-2013, Level I/Level II Kinetacore certification), was board certified in orthopedics, and was participating in a full time, orthopedic manual physical therapy fellowship training program at the time of the study. The clinical reasoning integral to the fellowship training was used in the examination and treatment progression of all patients in this observational study.

Dry Needling: The technique included insertion of a sterile, disposable, solid filament needle (Seirin Corp., Shizuoka, Japan) into the identified muscles. The size of the needle was either 0.30x50 mm or 0.30x60 mm based on the location of the muscle, the amount of muscle mass, and the amount of subcutaneous tissue that required penetration to reach the trigger point. Clean technique was used throughout all treatment procedures which involved hand

washing; use of clean, latex-free exam gloves; and cleaning the patient's skin with an alcohol swab prior to treatment.[46] The treating physical therapist administered dry needling to the muscles identified during the examination as having taut bands and/or palpable areas within the muscle that reproduced the primary shoulder symptoms of each patient. Each needle insertion lasted approximately five seconds using a sparrow pecking (in and out motion) technique.[47] Routine examination also included palpation of the cervical and thoracic paravertebral muscles; however, none of the patients in this study had identifiable trigger points in these areas. The tailored treatment approach continued by determining the patient's intra- and inter-session response to each application of dry needling and progressing examination and treatment accordingly. For example, at initial examination the physical therapist may have found three or more muscles with trigger points that correlated with a patient's symptoms however, dry needling treatment at the initial visit typically did not include more than two muscles. Prioritizing treatment to those areas thought to be most directly related to the presenting symptoms and functional impairment and limiting the number of trigger points treated allowed careful assessment of the results of treatment before providing additional treatment. Muscles identified as primary areas of trigger points sometimes required treatment at more than one visit. After treating the primary trigger points, the physical therapist would move on to treat secondary trigger points if they were still present. Appendix 1 provides the total number of visits in which each patient received dry needling, which muscles each patient received needling to at each visit, and how many trigger points were treated within each muscle. At each follow up, patients were questioned about adverse events following dry needling treatment.

Dry needling was explained to the patients as a treatment that consisted of inserting a thin needle into muscles that were identified as painful during the examination with the intent of eliciting contractions of the muscles. It was discussed with the patients that the desired effect of the treatment was to reduce pain and improve their movement and function.

Therapeutic Exercise: To observe the short-term effects of dry needling in this study, strengthening and range of motion exercises were not introduced until after measuring outcomes at the third patient visit. The treating physical therapist selected exercises that reinforced the dry needling treatments by addressing muscular weakness and movement impairments identified in the examination. Prior to leaving the clinic patients performed their exercises with the supervision of the physical therapist to assess performance and to ensure that the exercises did not provoke symptoms.[48] The carefully constructed exercise program evolved over the course of several appointments with the progression of exercises in volume or intensity or the addition of one or two exercises added at each appointment. The total number of exercises for each patient was based on impairments to strength and movement and each patient's ability to learn and perform exercise. Patients were instructed to perform strengthening exercises in three sets of ten repetitions in a range that did not provoke increased pain, with sets spread throughout the day, rather than back-to-back, if this allowed improved tolerance. Patients were instructed to perform movement exercises for five to ten repetitions in the morning, afternoon, and evening by moving the shoulder to the point of an initial increase of symptoms and holding in that position for 30 seconds, attempting to move a little further into the range during that period of time, without provoking a significant increase in symptoms. Each patient received an exercise tracking log to record exercise compliance. Appendix 1 also identifies the exercises prescribed to each patient over the course of the study. Patients used either a cane or the hand of their uninvolved side to help with movement exercises as needed. All strengthening exercises employed elastic bands or body weight for resistance.

OUTCOMES

Table 3 summarizes the demographics of the patients that participated in the study. Twenty-one out of the 25 patients in this case series were able to complete all outcome measures for all time points. Table 4 provides a complete accounting of the Q-DASH, NPRS, AROM, and GROC outcomes for each patient. Figure 2 shows the mean changes in Q-DASH and abduction AROM for all patients in the case series. No patients reported any adverse events other than localized pain during the dry needling treatment

Table 3. *Patient Demographics.*

Patient	Gender	Age	BMI	Duration of Symptoms (weeks)	Ethnicity
1	M	50	30.8	12	White
2	M	63	23.3	28	White
3	F	52	23.8	8	African American
4	M	37	29.7	3	African American
5	M	45	24.6	104	White
6	M	36	35.0	12	African American
7	M	38	29.7	12	White
8	M	50	28.9	4	African American
9	F	39	33.5	52	African American
10	M	30	26.9	4	Hispanic
11	M	35	27.6	12	White
12	F	34	24.8	8	Asian
13	F	37	27.6	2	Hispanic
14	M	45	25.0	16	White
15	F	41	31.1	52	African American
16	M	26	32.8	260	White
17	F	24	31.6	52	White
18	M	45	29.7	104	Hispanic
19	M	26	26.5	12	Hispanic
20	M	54	29.8	8	Hispanic
21	F	23	29.8	3	African American
22	M	34	29.8	8	Hispanic
23	F	59	33.1	12	White
24	F	43	28.1	12	African American
25	F	62	24.3	3	Asian

and minimal localized bruising following treatment. No patients required additional medical care or additional medications as a result of receiving dry needling treatment.

Q-DASH: After two dry needling treatments, 21 out of 24 patients reported improvement in Q-DASH scores ranging from 4.5 to 38.6 points lower than their baseline scores, with 8 of 24 (33%) exceeding the MCID of 16 points. At 3 months, 19 of 22 demonstrated improvements in the Q-DASH ranging from 0.1 to 54.5 points lower than their baseline scores, with 11 of 22 (50%) exceeding the MCID. (Figure 1)

NPRS: At the third visit 22 of 24 patients reported reduced pain on the NPRS ranging from 0.7 to 6.7 points less compared to baseline with 8 of 24 (33%) meeting the MCID. One patient reported a 0.6-point increase and another reported a 2.6-point increase in pain on the NPRS at the third visit. At 3 months 20 of the 22 patients reported improvement on the NPRS ranging from 0.4 to 6.3 points on the 11-point scale with 13 of 22 (59%) meeting the MCID.

Abduction AROM: Eighteen of 24 patients demonstrated limitation to abduction AROM at the initial examination. After two dry needling treatments, 15 of 18 patients with movement limitations at initial examination demonstrated improvement in their abduction AROM ranging from 10 degrees to 120 degrees compared to baseline, with 10 of the 18 (56%) exceeding the MCID. No patients experienced worsening AROM compared to baseline after the initial two dry needling treatments. At the 3-month follow-up, 14 of 16 (88%) patients with AROM impairments at baseline demonstrated improvements in abduction that exceeded the MCID. After demonstrating improvements in abduction AROM exceeding the MCID at the 2nd and 3rd visits, one patient (#20) had worse AROM at the 3-month follow-up. One patient (#19) demonstrated no changes in abduction AROM at any time point.

Table 4. *Individual Outcomes at Each Data Collection Point.*

Patient		Baseline	2nd Visit	3rd Visit	4-Week	3-Month
1	QDASH	29.55	20*	13.64*	15.9	4.5*
	NPRS	5.3	5.3	3	3	0.7
	AROM	90	100	140*	180*	180*
	GROC		3*	4*	5*	6*
2	QDASH	54.55	61.36	47.73	50	DNF
	NPRS	5.7	5.3	4.7	4.3	DNF
	AROM	80	95*	140*	170*	DNF
	GROC		0	3*	0	DNF
3	QDASH	50	25*	13.64*	6.8*	29.5*
	NPRS	7	3.3	0.33	1.3	3
	AROM	90	100	160*	180*	180*
	GROC		3*	6*	6*	5*
4	QDASH	27.27	20.5	15.9	34.1	38.6
	NPRS	4.3	4	3.3	4.3	4.3
	AROM	130	130	130	120	180*
	GROC		0	2	-4	-1
5	QDASH	13.64	22.73	9.09	11.36	6.82
	NPRS	2	4	1.3	1.3	0.67
	AROM	160	170	180*	180*	180*
	GROC		-3	3*	5*	6*
6	QDASH	40.9	43.2	36.4	11.36*	2.27*
	NPRS	6.3	4.3	4.3	2.3	0.33
	AROM	90	180*	180*	180*	180*
	GROC		0	1	5*	6*
7	QDASH	22.73	27.3	11.36	9.1	18.18
	NPRS	2	2	2	1.7	2
	AROM	180	180	180	180	180
	GROC		0	0	0	0
8	QDASH	20.5	18.2	6.8	9.09	9.09
	NPRS	5.7	3.7	2.7	1.3	1.3
	AROM	150	130	170*	180*	180*
	GROC		0	3*	6*	6*
9	QDASH	29.5	15.9	0*	0*	0*
	NPRS	5.7	2.3	1.3	0	0.67
	AROM	110	150*	180*	180*	180*
	GROC		4*	6*	7*	6*
10	QDASH	25	27.3	31.8	DNF	DNF
	NPRS	2	1.7	0.3	DNF	DNF
	AROM	180	180	180	DNF	DNF
	GROC		0	0	DNF	DNF
11	QDASH	20.45	6.8	2.3*	0*	0*
	NPRS	1.7	0	0	0.33	0
	AROM	180	180	180	180	180
	GROC		4*	6*	6*	5*
12	QDASH	63.6	65.9	50	30*	27.5*
	NPRS	7	6	5.3	3.7	3.3
	AROM	70	90*	120*	160*	180*
	GROC		3*	3*	5*	6*
13	QDASH	50	52.27	65.9	45.5	34.09
	NPRS	4.7	6	7.3	4.3	2
	AROM	80	120*	90	110*	110*
	GROC		0	-5	2	4*
14	QDASH	18.2	11.36	2.3*	DNF	0*
	NPRS	1	0.3	0	DNF	0
	AROM	180	180	180	DNF	180
	GROC		5*	6*	DNF	6*

Table 4. *Individual Outcomes at Each Data Collection Point. (continued)*

Patient		Baseline	2nd Visit	3rd Visit	4-Week	3-Month
15	QDASH	52.3	43.2	45.5	38.6	61.36
	NPRS	5	4	4.3	3	5.3
	AROM	120	130	140*	140*	145*
	GROC		2	5*	4*	3*
16	QDASH	15.9	15.9	25	11.4	2.27
	NPRS	3.7	3	4.3	2.7	0.67
	AROM	140	160*	140	130	180*
	GROC		3*	3*	5*	7*
17	QDASH	36.4		Withdrew		
	NPRS	7.3		Withdrew		
	AROM	100		Withdrew		
	GROC			Withdrew		
18	QDASH	20.5	25	13.6	20.45	20.45
	NPRS	2	1.3	1.3	2.3	2
	AROM	130	180*	180*	180*	180*
	GROC		0	4*	3*	4*
19	QDASH	11.36	6.82	9.09	9.09	13.63
	NPRS	4.7	4	3.67	3.3	4.3
	AROM	90	90	90	90	90
	GROC		0	0	0	0
20	QDASH	54.5	18.18*	31.8*	34.09*	38.6*
	NPRS	3	1.3	2.3	3	4.3
	AROM	95	140*	150*	80	90
	GROC		1	2	3*	4*
21	QDASH	27.3	20.45	20.45	0*	0*
	NPRS	3	1.7	2	0	0
	AROM	180	180	180	180	180
	GROC		1	4*	6*	6*
22	QDASH	13.63	11.36	6.8	9.09	4.54
	NPRS	4	2.3	2.3	1.3	0.33
	AROM	180	180	180	180	180
	GROC		1	0	5*	7*
23	QDASH	54.54	68.18	36.36*	9.09*	0*
	NPRS	6.3	7	4.3	1	0
	AROM	65	65	125*	180*	180*
	GROC		-3	3*	6*	7*
24	QDASH	34.1	27.27	20.45	13.63*	15.9
	NPRS	6	3.33	3.67	3	1.7
	AROM	115	120	135*	145*	145*
	GROC		5*	2	4*	6*
25	QDASH	25	15.9	2.27*	27.27	6.8*
	NPRS	4.3	2	1	3	0.7
	AROM	60	125*	180*	180*	180*
	GROC		1	7*	6*	6*

DNF – Did not follow-up
* Indicates MCID met compared to baseline

GROC: After two dry needling treatments, 15 of 24 patients (63%) reported GROC scores of +3 or greater, eight of 24 (33%) reported GROC scores of 0 to +2, and one of 24 (4%) reported a GROC score of -5. At the 3-month follow-up two patients reported GROC scores of 0 and one reported a score of -1, while 19 of 22 patients (86%) reported GROC scores of +3 or greater, with 13 reporting they were "a great deal better" (+6) or "a very great deal better" (+7). (Figure 2)

DISCUSSION

To the authors' knowledge, this is the first large case series describing the pragmatic application of dry needling and exercise for patients with SAPS.

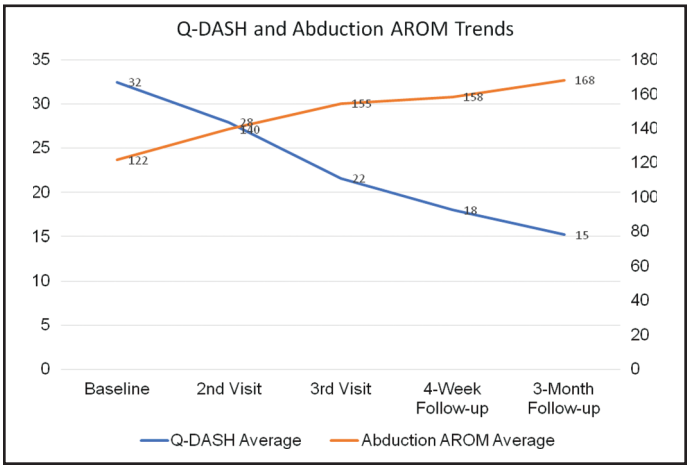

Figure 1. *Primary y-axis (on left): Mean changes in Q-DASH from Baseline to 3-Month Follow-up. Secondary y-axis (on right): Mean changes in Abduction AROM from Baseline to 3-Month Follow-up.*

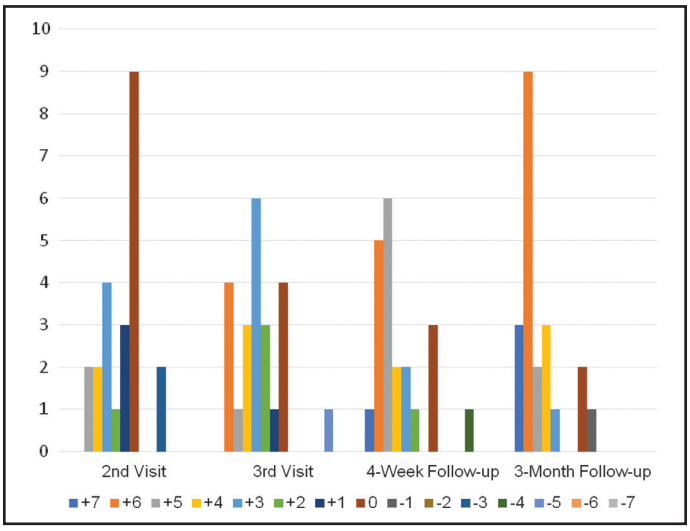

Figure 2. *Global Rating of Change Scores (GROC)*

+7, A very great deal better
+6, A great deal better
+5, Quite a bit better
+4, Moderately better
+3, Somewhat better – Set as the MCID for this study.
+2, A little bit better
+1, A tiny bit better (almost the same)
0, About the same
-1, A tiny bit worse (almost the same)
-2, A little bit worse
-3, Somewhat worse
-4, Moderately worse
-5, Quite a bit worse
-6, A great deal worse
-7, A very great deal worse

NOTE:
2nd Visit: 8 patients reported GROC +3 or greater; 13 patients reported 0 thru +2; 2 patients reported less than 0
3rd Visit: 14 patients reported GROC +3 or greater; 8 patients reported 0 thru +2; 1 patient reported less than 0
4-Week Follow-up: 16 patients reported GROC +3 or greater; 4 patients reported 0 thru +2; 1 patient reported less than 0
3-Month Follow-up: 12 patients reported GROC +3 or greater; 2 patients reported 0 thru 2; 1 patient reported less than 0

Thirteen of twenty-four patients (54%) reported clinically meaningful improvements on the Q-DASH after two dry needling treatments. At 3 months, 16 of 22 patients (72%) reported improvement on the Q-DASH that surpassed the MCID.

Some muscles had multiple trigger points that each warranted treatment. The reported frequency of muscles needled in this study (Appendix 1) represents each time a needle was inserted into a muscle to treat a trigger point. For the patients in this case series, the supraspinatus and the pectoralis minor muscles were the most frequent locations of trigger points. Because primary trigger points sometimes required more than one treatment session to resolve, these muscles were needled most frequently.

A strength of this case series is that the design provided an opportunity to observe the immediate effects of dry needling in isolation since exercises were withheld until the third visit and after the third measure of the dependent variables. In typical clinical practice, we would prescribe appropriate individualized exercises immediately following dry needling at the initial treatment session. We observed that with two applications of dry needling, some patients experienced rapid improvements in pain, function, and shoulder motion (Table 4). It is possible that treatment expectations or a placebo effect contributed to the positive responses reported and demonstrated by the patients. Perhaps the pain relief observed with the dry needling provides a window of decreased symptoms to initiate exercise for additional movement and strength gains. An interesting observation was the rapid improvements in motion for patients who presented with movement impairments. These improvements may be due to changes in rotator cuff guarding through range because of the dry needling. These changes decreased the number of movement exercises required and may have facilitated a more rapid introduction of strengthening exercises through the improved range of motion. After the initiation of exercise, patients appeared to continue to improve consistent with the reported outcomes and prognosis for patients with SAPS treated with an exercise program.[8,13,49]

The four-week and three-month outcomes of this case series are similar to outcomes reported in previous studies examining exercise and manual therapy for patients with SAIS.[9,10,45] However, the previous studies

did not report immediate (within the first three visits) outcomes as described in this study. The improvements in ROM, shoulder function and pain reported by most, but not all, patients within the first two visits suggests dry needling may be a useful adjunct to exercise for some patients with a clinical diagnosis of SAPS. These findings may suggest a subgroup of patients meeting the clinical diagnosis of SAPS that are more responsive to dry needling interventions.

This case series utilized an examination and impairment-based treatment approach using consistent clinical reasoning. Information derived from the interview revealed the likely tolerance of the patient to examination and treatment. The physical therapist's assessment of symptom location and behavior, functional limitations, palpable trigger points, physiologic and accessory shoulder and spine range of motion, and shoulder muscle function determined the type, focus, duration, and dose of the interventions. Detailed ongoing assessment of patient status revealed the response to selected interventions and intervention sessions.[42] The treating physical therapist applied clinical reasoning based on this ongoing assessment to determine when and what to dry needle as well as the type and dose of exercises that would be most appropriate for each patient.

The potential for other body regions and disorders to contribute to the signs and symptoms attributed to SAPS as well as variance in the clinical presentation of impingement syndrome underscores the importance of performing a thorough examination that guides impairment-based intervention. This approach may provide a more direct path to functional improvement than a protocol-based intervention based on a specific diagnosis. In clinical practice, a patient diagnosed with SAPS may present with trigger points as well as limitations in joint mobility that would respond to both dry needling and other forms of physical therapy such as manual mobilization in addition to exercise. The observations from this study provide preliminary evidence that utilizing dry needling early in the intervention process for patients with SAPS may be beneficial; however, it also suggests that dry needling may not provide the same level of benefit to all patients. In this case series, each patient received dry needling based on clinical reasoning and matched interventions to the impairments identified during examination. Despite having GROC scores of +3 or greater at the 3-month follow-up, patients 1, 13, 15, and 24 each demonstrated improvements in ROM but never obtained full abduction AROM, possibly indicating that this group may have benefitted from additional movement-based interventions such as manual physical therapy. Given the potential for rapid improvements with dry needling as seen in the majority of these patients, one approach would be to address primary trigger points with 1-2 appropriately matched movement and/or strengthening exercises at the initial visit to reinforce the initial benefit of dry needling. Upon follow-up, 3-5 days later, if the patient has a positive response to the dry needling and exercise combination, but continues to have joint mobility deficits, dry needling treatment could be continued and progressed to additional trigger points while also initiating joint mobilization and reinforcing assisted active ROM exercises. Alternatively, if the patient does not have a positive response to dry needling, while still re-assessing trigger points and possibly progressing dry needling, greater emphasis may be placed on more thorough manual joint mobility assessment and treatment followed by the appropriate reinforcing exercises. Table 5 presents a potential treatment pathway based on patient presentation for this treatment model.

The authors acknowledge several limitations in this study. First, the observational design of a case series prevents the inference of any cause and effect relationships related to the reported outcomes. Second, due to the nature of the applied interventions, the therapist and patient were not blinded to the treatment received and, consistent with typical clinical practice, the treating physical therapist was responsible for describing the treatment which could also impact the self-report primary (Q-DASH) and secondary (NPRS and GROC) outcome measures. Third, generalizability of the results is limited due to a single therapist performing all examinations, interventions, and collection of outcome measures. Additionally, all patients in this case series were active duty service members or their beneficiaries and received care at the same facility. Despite the limitations of this case series, the results are encouraging for dry needling as a precursor and adjunct to exercise for treating patients with SAPS.

CONCLUSIONS

This case series describes the outcomes of dry needling combined with exercise for patients with SAPS

Table 5. *Possible subacromial pain syndrome treatment pathway with dry needling, based on patient presentation.*

Initial Examination	Trigger points/taut bands identified	Joint mobility impairments identified	**Treatment:** Dry needling to the primary trigger point(s) 1-2 appropriately matched movement or strengthening exercises
1st Follow-Up	**Positive Response to Dry Needling:** Progress dry needling and appropriately matched movement or strengthening exercises if indicated. If no additional dry needling is indicated and joint mobility impairments persist, transition to joint mobilization treatment. Reinforce joint mobilization with appropriate ROM exercises.	**Negative Response to Dry Needling:** Re-assess trigger points, use clinical judgment and patient preferences to determine if additional dry needling treatment is warranted at this time. Re-assess joint mobility impairments and initiate joint mobilization treatment. Reinforce joint mobilization with appropriate assisted ROM exercises.	**No Response to Dry Needling:** If still present, re-treat primary trigger points. Re-assess secondary trigger points and treat if indicated. Add 1-2 appropriately matched movement or strengthening exercises.
2nd Follow-Up	**Positive Response to Dry Needling:** Progress dry needling and appropriately matched movement or strengthening exercises if indicated. If no additional dry needling is indicated and joint mobility impairments persist, transition to joint mobilization treatment. Reinforce joint mobilization with appropriate assisted ROM exercises.	**Negative Response to Dry Needling:** Re-assess trigger points, use clinical judgment and patient preferences to determine if additional dry needling treatment is warranted at this time. Re-assess joint mobility impairments and initiate joint mobilization treatment. Reinforce joint mobilization with appropriate assisted ROM exercises.	**No Response to Dry Needling:** Re-assess joint mobility impairments and initiate joint mobilization treatment. Reinforce joint mobilization with appropriate assisted ROM exercises. Add 1-2 appropriately matched movement or strengthening exercises.
Subsequent Visits	Continue with appropriate progression of manual therapy and exercises as indicated.	If patient previously responded positively to dry needling, continually re-assess and treat trigger points if they return throughout the episode of care.	

and provides discussion on the framework of clinical reasoning used in the clinical application of dry needling. With the current substantial evidence supporting exercise for patients with SAPS and limited evidence that manual therapy may increase the effects of exercise interventions, future studies should focus on determining if dry needling adds to these effects in a meaningful way. Variables such as chronicity of symptoms, mechanism of injury, job/sport requirements, joint versus muscular impairments, age, gender, other health impairments, and other factors may prove to be indicators of patients that would or would not benefit from dry needling for SAPS. Future studies should also focus on identifying subgroups within this patient population that would be likely to respond favorably to dry needling intervention as part of a comprehensive treatment plan.

REFERENCES

1. Luime JJ, Koes BW, Hendriksen IJ, et al. Prevalence and incidence of shoulder pain in the general population; a systematic review. *Scand J Rheumatol.* 2004;33(2):73-81.
2. Meislin RJ, Sperling JW, Stitik TP. Persistent shoulder pain: epidemiology, pathophysiology, and diagnosis. *Am J Orthop (Belle Mead NJ).* 2005;34(12 Suppl):5-9.

3. Walsworth MK, Doukas WC, Murphy KP, Bimson W, Mielcarek BJ, Michener LA. Descriptive analysis of patients undergoing shoulder surgery at a tertiary care military medical center. *Mil Med.* 2009;174(6):642-644.
4. Wofford JL, Mansfield RJ, Watkins RS. Patient characteristics and clinical management of patients with shoulder pain in U.S. primary care settings: secondary data analysis of the National Ambulatory Medical Care Survey. *BMC Musculoskelet Disord.* 2005;6:4.
5. Diercks R, Bron C, Dorrestijn O, et al. Guideline for diagnosis and treatment of subacromial pain syndrome: a multidisciplinary review by the Dutch Orthopaedic Association. *Acta Orthop.* 2014;85(3):314-322.
6. Morrison DS, Frogameni AD, Woodworth P. Non-operative treatment of subacromial impingement syndrome. *J Bone Joint Surg Am.* 1997;79(5):732-737.
7. van der Sande R, Rinkel WD, Gebremariam L, Hay EM, Koes BW, Huisstede BM. Subacromial impingement syndrome: effectiveness of pharmaceutical interventions-nonsteroidal anti-inflammatory drugs, corticosteroid, or other injections: a systematic review. *Arch Phys Med Rehabil.* 2013;94(5):961-976.
8. Hanratty CE, McVeigh JG, Kerr DP, et al. The effectiveness of physiotherapy exercises in subacromial impingement syndrome: a systematic review and meta-analysis. *Sem Arthr Rheum.* 2012;42(3):297-316.
9. Rhon DI, Boyles RB, Cleland JA. One-year outcome of subacromial corticosteroid injection compared with manual physical therapy for the management of the unilateral shoulder impingement syndrome: a pragmatic randomized trial. *Ann Intern Med.* 2014;161(3):161-169.
10. Bang MD, Deyle GD. Comparison of supervised exercise with and without manual physical therapy for patients with shoulder impingement syndrome. *J Orthop Sports Phys Ther.* 2000;30(3):126-137.
11. Kromer TO, de Bie RA, Bastiaenen CH. Effectiveness of individualized physiotherapy on pain and functioning compared to a standard exercise protocol in patients presenting with clinical signs of subacromial impingement syndrome. A randomized controlled trial. *BMC Musculoskelet Disord.* 2010;11:114.
12. Dorrestijn O, Stevens M, Winters JC, van der Meer K, Diercks RL. Conservative or surgical treatment for subacromial impingement syndrome? A systematic review. *J Shoulder Elbow Surg.* 2009;18(4):652-660.
13. Kuhn JE. Exercise in the treatment of rotator cuff impingement: a systematic review and a synthesized evidence-based rehabilitation protocol. *J Shoulder Elbow Surg.* 2009;18(1):138-160.
14. Ginn KA, Cohen ML. Exercise therapy for shoulder pain aimed at restoring neuromuscular control: a randomized comparative clinical trial. *J Rehabil Med.* 2005;37(2):115-122.
15. Bron C, Dommerholt J, Stegenga B, Wensing M, Oostendorp RA. High prevalence of shoulder girdle muscles with myofascial trigger points in patients with shoulder pain. *BMC Musculoskelet Disord.* 2011;12:139.
16. Ge HY, Fernandez-de-Las-Penas C, Yue SW. Myofascial trigger points: spontaneous electrical activity and its consequences for pain induction and propagation. *Chin Med.* 2011;6:13.
17. Simons DG, Travell JG, Simons LS, Travell JG. *Travell & Simons' myofascial pain and dysfunction : the trigger point manual.* 2nd ed. Baltimore: Williams & Wilkins; 1999.
18. Shah JP, Danoff JV, Desai MJ, et al. Biochemicals associated with pain and inflammation are elevated in sites near to and remote from active myofascial trigger points. *Arch Phys Med Rehabil.* 2008;89(1):16-23.
19. Shah JP, Gilliams EA. Uncovering the biochemical milieu of myofascial trigger points using in vivo microdialysis: an application of muscle pain concepts to myofascial pain syndrome. *J Bodyw Mov Ther.* 2008;12(4):371-384.
20. Dommerholt J. Dry needling - peripheral and central considerations. *J Man Manip Ther.* 2011;19(4):223-227.
21. Hsieh YL, Yang SA, Yang CC, Chou LW. Dry needling at myofascial trigger spots of rabbit skeletal muscles modulates the biochemicals associated with pain, inflammation, and hypoxia. *Ev Based Complement Alt Med : eCAM.* 2012;2012:342165.
22. Tough EA, White AR, Richards S, Campbell J. Variability of criteria used to diagnose myofascial trigger point pain syndrome--evidence from a review of the literature. *Clin J Pain.* 2007;23(3):278-286.
23. Lucas N, Macaskill P, Irwig L, Moran R, Bogduk N. Reliability of physical examination for diagnosis of myofascial trigger points: a systematic review of the literature. *Clin J Pain.* 2009;25(1):80-89.
24. Gattie E, Cleland JA, Snodgrass S. The effectiveness of trigger point dry needling for musculoskeletal conditions by physical therapists: A systematic review and meta-analysis. *J Orthop Sports Phys Ther.* 2017;47(3):133-149.
25. Boyles R, Fowler R, Ramsey D, Burrows E. Effectiveness of trigger point dry needling for multiple body regions: a systematic review. *J Man Manip Ther.* 2015;23(5):276-293.
26. Kietrys DM, Palombaro KM, Azzaretto E, et al. Effectiveness of dry needling for upper-quarter

myofascial pain: a systematic review and meta-analysis. *J Orthop Sports Phys Ther.* 2013;43(9):620-634.

27. Liu L, Huang QM, Liu QG, et al. Effectiveness of dry needling for myofascial trigger points associated with neck and shoulder pain: a systematic review and meta-analysis. *Arch Phys Med Rehabil.* 2015;96(5):944-955.
28. Arias-Buría JL, Fernández-de-Las-Peñas C, Palacios-Ceña M, Koppenhaver SL, Salom-Moreno J. Exercises and Dry Needling for Subacromial Pain Syndrome: A Randomized Parallel-Group Trial. *J Pain.* 2017;18(1):11-18.
29. Pérez-Palomares S, Oliván-Blázquez B, Pérez-Palomares A, et al. Contribution of Dry Needling to Individualized Physical Therapy Treatment of Shoulder Pain: A Randomized Clinical Trial. *J Orthop Sports Phys Ther.* 2017;47(1):11-20.
30. Osborne NJ, Gatt IT. Management of shoulder injuries using dry needling in elite volleyball players. *Acupunct Med.* 2010;28(1):42-45.
31. Ingber RS. Shoulder impingement in tennis/racquetball players treated with subscapularis myofascial treatments. *Arch Phys Med Rehabil.* 2000;81(5):679-682.
32. Angst F, Schwyzer HK, Aeschlimann A, Simmen BR, Goldhahn J. Measures of adult shoulder function: Disabilities of the Arm, Shoulder, and Hand Questionnaire (DASH) and its short version (QuickDASH), Shoulder Pain and Disability Index (SPADI), American Shoulder and Elbow Surgeons (ASES) Society standardized shoulder assessment form, Constant (Murley) Score (CS), Simple Shoulder Test (SST), Oxford Shoulder Score (OSS), Shoulder Disability Questionnaire (SDQ), and Western Ontario Shoulder Instability Index (WOSI). *Arthritis Care Res.* 2011;63 Suppl 11:S174-188.
33. Hunsaker FG, Cioffi DA, Amadio PC, Wright JG, Caughlin B. The American academy of orthopaedic surgeons outcomes instruments: normative values from the general population. *J Bone Joint Surg Am.* 2002;84-A(2):208-215.
34. Franchignoni F, Vercelli S, Giordano A, Sartorio F, Bravini E, Ferriero G. Minimal clinically important difference of the disabilities of the arm, shoulder and hand outcome measure (DASH) and its shortened version (QuickDASH). *J Orthop Sports Phys Ther.* 2014;44(1):30-39.
35. Michener LA, Snyder AR, Leggin BG. Responsiveness of the numeric pain rating scale in patients with shoulder pain and the effect of surgical status. *J Sport Rehabil.* 2011;20(1):115-128.
36. Mintken PE, Glynn P, Cleland JA. Psychometric properties of the shortened disabilities of the Arm, Shoulder, and Hand Questionnaire (QuickDASH) and Numeric Pain Rating Scale in patients with shoulder pain. *J Should Elbow Surg.* 2009;18(6):920-926.
37. Frost P, Andersen JH. Shoulder impingement syndrome in relation to shoulder intensive work. *Occup Environ Med.* 1999;56(7):494-498.
38. Lo YP, Hsu YC, Chan KM. Epidemiology of shoulder impingement in upper arm sports events. *Br J Sports Med.* 1990;24(3):173-177.
39. Muir SW, Corea CL, Beaupre L. Evaluating change in clinical status: reliability and measures of agreement for the assessment of glenohumeral range of motion. *N Am J Sports Phys Ther.* 2010;5(3):98-110.
40. Jaeschke R, Singer J, Guyatt GH. Measurement of health status. Ascertaining the minimal clinically important difference. *Control Clin Trials.* 1989;10(4):407-415.
41. Maitland GD, Edwards BC. *Vertebral manipulation.* 5th ed. London ; Boston: Butterworths; 1986.
42. Baker SE, Painter EE, Morgan BC, et al. Systematic clinical reasoning in physical therapy (SCRIPT): tool for the purposeful practice of clinical reasoning in orthopedic manual physical therapy. *Phys Ther.* 2016.
43. Hegedus EJ, Goode AP, Cook CE, et al. Which physical examination tests provide clinicians with the most value when examining the shoulder? Update of a systematic review with meta-analysis of individual tests. *Br J Sports Med.* 2012;46(14):964-978.
44. Hengeveld E, Banks K. *Maitland's Peripheral Manipulation.* 4th ed: Butterworth-Heinemann; 2005.
45. Rhon DI, Boyles RE, Cleland JA, Brown DL. A manual physical therapy approach versus subacromial corticosteroid injection for treatment of shoulder impingement syndrome: a protocol for a randomised clinical trial. *BMJ open.* 2011;1(2):e000137.
46. Baima J, Isaac Z. Clean versus sterile technique for common joint injections: a review from the physiatry perspective. *Curr Rev Musculoskel Med.* 2008;1(2):88-91.
47. Itoh K, Katsumi Y, Hirota S, Kitakoji H. Effects of trigger point acupuncture on chronic low back pain in elderly patients--a sham-controlled randomised trial. *Acupunct Med.* 2006;24(1):5-12.
48. Deyle GD, Gill NW. Well-tolerated strategies for managing knee osteoarthritis: a manual physical therapist approach to activity, exercise, and advice. *Phys Sportsmed.* 2012;40(3):12-25.
49. Lombardi I, Magri AG, Fleury AM, Da Silva AC, Natour J. Progressive resistance training in patients with shoulder impingement syndrome: a randomized controlled trial. *Arthritis Rheum.* 2008;59(5):615-622.

Appendix 1. *Specifics of treatment for each patient.*

Patient	Total Visits	# of DN Treatments	Muscles Needled (# of TPs needled per muscle)	Exercises Prescribed
1	7	6	**Visit 1:** Supraspinatus (3), pectoralis minor (2) **Visit 2:** Deltoid (3), infraspinatus (3) **Visit 3:** Deltoid (2) **Visit 4:** Deltoid (4) **Visit 5:** Deltoid (2) **Visit 6:** Infraspinatus (3)	**Movement**: Assisted flexion, assisted abduction **Strength**: external rotation, internal rotation, scapular row, abduction
2	7	6	**Visit 1:** Teres minor (2), upper trapezius (3) **Visit 2:** Teres minor (2), upper trapezius (3), latissimus dorsi (2) **Visit 3:**Pectoralis minor (2), upper trapezius (2) **Visit 4:**Teres minor (2) **Visit 5:** Deltoid (3) **Visit 6:** Pectoralis minor (2)	**Movement**: Pendulum, assisted hand behind back, **Strength:** Abduction, scapular row, external rotation, internal rotation
3	8	6	**Visit 1:** Supraspinatus (3), upper trapezius (3) **Visit 2:** Infraspinatus (2), upper trapezius (2), pectoralis minor (2) **Visit 3:**Teres minor (3) **Visit 4:** Pectoralis minor (4), upper trapezius (3) **Visit 5:** Pectoralis minor (2), teres minor (2) **Visit 6:** Pectoralis minor (3), teres minor (2), infraspinatus (3)	**Movement:** Assisted hand behind back **Strength:** Scapular row, external rotation, internal rotation
4	7	2	**Visit1:** Supraspinatus (2), infraspinatus (3), teres minor (2) **Visit 2:** Pectoralis minor (3), deltoid (3)	**Movement:** None **Strength:** external rotation, internal rotation, abduction, scapular row

Appendix 1. *Specifics of treatment for each patient. (continued)*

Patient	Total Visits	# of DN Treatments	Muscles Needled (# of TPs needled per muscle)	Exercises Prescribed
5	5	2	**Visit 1:** Teres minor (3), biceps (2) **Visit 2:** Teres minor (3)	**Movement:** None **Strength:** shoulder protraction, scapular row, push-up progression
6	6	1	**Visit 1:** Infraspinatus (3), supraspinatus (3)	**Movement:** None **Strength:** external rotation, internal rotation, scapular row, shoulder protraction, push-up progression
7	6	1	**Visit 1:** Infraspinatus (3), teres minor (3)	**Movement:** Anterior shoulder stretch **Strength:** Scapular row, upper trapezius, middle trapezius, abduction
8	7	3	**Visit 1:** Pectoralis minor (3), deltoid (3), teres minor (3) **Visit 2:** Pectoralis minor (3), deltoid (3) **Visit 3:** Deltoid (2)	**Movement:** None **Strength:** internal rotation, scapular row, external rotation, abduction, push-up progression
9	5	2	**Visit 1:** Rhomboids (3), upper trapezius (2) **Visit 2:** rhomboids (2), teres minor (2), infraspinatus (2)	**Movement:** None **Strength:** external rotation, middle trapezius, scapular row, abduction, push-up progression
10	4	4	**Visit 1:** Pectoralis minor (2), teres minor (2), supraspinatus (2) **Visit 2:** Pectoralis minor (2), teres minor (2), supraspinatus (3) **Visit 3:** Teres minor (2), supraspinatus (3) **Visit 4:** Infraspinatus (3)	**Movement:** Pendulum **Strength:** scapular row, abduction

Appendix 1. *Specifics of treatment for each patient. (continued)*

Patient	Total Visits	# of DN Treatments	Muscles Needled (# of TPs needled per muscle)	Exercises Prescribed
11	5	1	**Visit 1:** pectoralis minor (3), supraspinatus (2), coaracobrachialis (1)	**Movement:** None **Strength:** internal rotation, scapular row, abduction, push-up progression
12	12	5	**Visit 1:** Pectoralis minor (2), supraspinatus (2), infraspinatus (1), teres minor (2) **Visit 2:** Teres minor (3), upper trapezius (3) **Visit 3:** Teres minor (3), supraspinatus (3) **Visit 4:** infraspinatus (3), supraspinatus (3) **Visit 5:** Supraspinatus (2), deltoid (3)	**Movement:** Anterior shoulder stretch **Strength:** External rotation, middle trapezius, scapular row, shoulder protraction
13	7	3	**Visit 1:** Pectoralis minor (3), teres minor (3) **Visit 2:** Upper trapezius (3), supraspinatus (3) **Visit 7:** Supraspinatus (4), upper trapezius (2)	**Movement:** Assisted hand behind back, assisted abduction, upper trapezius stretch, levator scapula stretch **Strength:** External rotation, internal rotation, forward flexion, scapular row
14	3	1	**Visit 1:** Deltoid (3)	**Movement:** None **Strength:** Scapular row, internal rotation, external rotation
15	8	4	**Visit 1:** Pectoralis minor (3), upper trapezius (3) **Visit 2:** Pectoralis minor (3), deltoid (2), supraspinatus (3) **Visit 3:** Supraspinatus (3), teres minor (2), upper trapezius (3) **Visit 7:** Deltoid (3), supraspinatus (3)	**Movement:** Upper trapezius stretch, levator scapula stretch, posterior shoulder stretch **Strength:** Abduction, push-up progression, serratus punch (supine), external rotation

Appendix 1. *Specifics of treatment for each patient. (continued)*

Patient	Total Visits	# of DN Treatments	Muscles Needled (# of TPs needled per muscle)	Exercises Prescribed
16	7	5	**Visit 1:** Pectoralis minor (4), deltoid (3), teres minor (3) **Visit 2:** Supraspinatus (3), infraspinatus (3), teres minor (2) **Visit 3:** Supraspinatus (3), pectoralis minor (3) **Visit 4:** Teres minor (2), pectoralis minor (2), latissimus dorsi (2) **Visit 5:** Pectoralis minor (3), deltoid (3)	**Movement:** Anterior shoulder stretch **Strength:** External rotation, internal rotation, middle trapezius, lower trapezius, abduction
17		Withdrew	Withdrew from study	
18	8	3	**Visit 1:** Pectoralis minor (3), biceps (2) **Visit 2:** Infraspinatus (3), supraspinatus (3) **Visit 4:** Supraspinatus (3)	**Movement:** Anterior chest stretch **Strength:** Scapular row, internal rotation, external rotation, push-up progression, abduction
19	6	2	**Visit 1:** Pectoralis minor (3), deltoid (3) **Visit 2:** Supraspinatus (3), infraspinatus (3)	**Movement:** None **Strength:** External rotation, scapular row, push-up plus, middle trapezius, lower trapezius, internal rotation, scaption
20	7	3	**Visit 1:** Supraspinatus (2), infraspinatus (2) **Visit 2:** Supraspinatus (3), infraspinatus (3), deltoid (2) **Visit 3:** Supraspinatus (4), rhomboids (4)	**Movement:** None **Strength:** Scapular row, lower trapezius
21	7	2	**Visit 1:** Pectoralis minor (3), rhomboids (3) **Visit 2:** Supraspinatus (3), upper trapezius (3)	**Movement:** None **Strength:** Middle trapezius, lower trapezius, internal rotation, external rotation

Appendix 1. *Specifics of treatment for each patient. (continued)*

Patient	Total Visits	# of DN Treatments	Muscles Needled (# of TPs needled per muscle)	Exercises Prescribed
22	7	1	**Visit 1:** Pectoralis minor (3)	**Movement:** Anterior shoulder stretch **Strength:** Internal rotation, middle trapezius, lower trapezius, push-up progression
23	5	2	**Visit 1:** Supraspinatus (5), upper trapezius (3) **Visit 2:** Infraspinatus (1), deltoid (1)	**Movement:** Radial nerve glide, upper trap stretch, levator scapulae stretch
24	7	3	**Visit 1:** Supraspinatus (5), infraspinatus (5) **Visit 2:** teres minor (2), pectoralis minor (3) **Visit 3:** deltoid (3)	**Movement:** Assisted hand behind back **Strength:** External rotation, middle trapezius, lower trapezius, push-up progression
25	5	2	**Visit 1:** Infraspinatus (2), teres minor (2) **Visit 2:** Pectoralis minor (2), deltoid (2)	**Movement:** None **Strength:** Internal rotation, external rotation, scapular row